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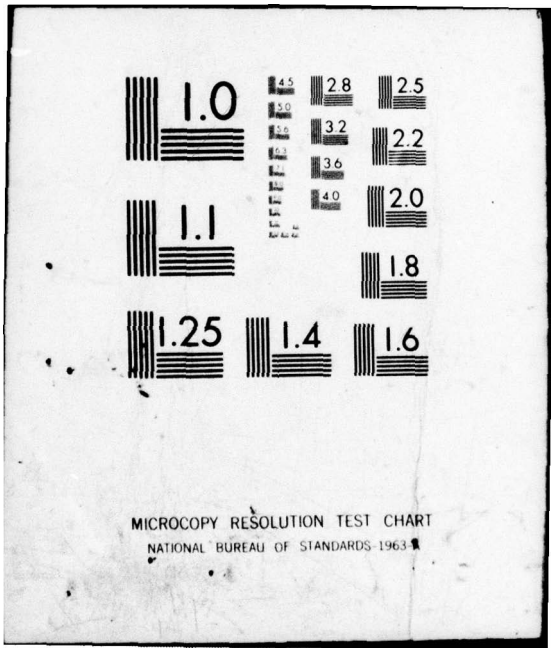
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AEROMEDICAL REVIEW

PSYCHOMETRIC CHARACTERISTICS OF ASTRONAUTS

March 1977

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Detailed information on the role of psychological testing in the selection process for NASA astronauts has been reported only in a fragmentary manner because of the sensitive nature of this information. With the lapse of time since the initiation of the U.S. manned space program, this information has become essentially of only historic interest. However, because of the current activity in the European space agency, where there is a requirement for astronaut selection, psychometric procedures and data are of renewed scientific interest. An overview of the psychometric process and extensive statistical analyses are reported.

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PSYCHOMETRIC CHARACTERISTICS OF ASTRONAUTS

INTRODUCTION

The general procedures used in the selection process for National Aeronautics and Space Administration (NASA) astronauts have been reported in a variety of public and scientific media in the United States. Detailed information on psychological testing (one small part of the selection process) has been reported only in a fragmentary (and sometimes obscure) manner (3-6) because of the sensitive nature of such information.[1] Because of the lapse of time since the initiation of the U.S. manned space program (Mercury, Gemini, Apollo), this information has become essentially of only historical interest. However, the current activity in the European space agency, where there is a requirement for astronaut selection, renews scientific interest in psychometric procedures and data. This review will describe the psychometric process and present representative data.

OVERVIEW OF THE PSYCHOMETRIC PROCESS

Without exception, psychological testing has been embedded in a larger medical evaluation program. However, the overall medical program differed for Mercury versus remaining astronaut selection programs. Table 1 summarizes the two approaches. For the most part, candidates were examined in groups of six over a one-week period. Note the two-phase/two-location process for Mercury candidates, followed by consolidation of both the evaluation components and the location for subsequent groups of candidates. The findings in all cases were submitted to NASA in the form of an extensive consultation report on each candidate. NASA physicians were frequently present as advisors/observers during the medical evaluations. At such times, they participated actively in the case conferences held on each candidate.

The psychological tests administered to Mercury candidates at the Aerospace Medical Research Laboratory and to all subsequent candidates at the USAF School of Aerospace Medicine (USAFSAM) are shown in Table 2. In general, each laboratory used a conventional clinical psychological battery augmented because of special factors.

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[1]This review has been cleared by NASA Headquarters and by Headquarters USAF. In addition, a review relative to Privacy Act requirements was performed by ABG/JA, Brooks AFB, Tex.

TABLE 1. OVERVIEW OF PSYCHOMETRICS*

Procedures	Remarks
Mercury Candidates	
Medical evaluation	Performed at Lovelace Foundation, Albuquerque, New Mexico.
Stress tolerance evaluation (ref. 9)[a]	Performed at 6570 AMRL, Wright-Patterson AFB, Ohio.
Battery of stress tolerance tests	Derivative of earlier drug studies using stress-provocative tests.
Psychiatric examination	Keyed to space flight stress.
* Psychometric testing	Conventional test battery.
* Pilot aptitude test battery	WWII pilot selection tests.
Psychiatric observation/brief psychometric tests; before and after each stress test.	Special brief tests from Moran battery.
Gemini-Apollo Candidates	
Medical evaluation (ref. 7)[b]	Performed at USAFSAM, Brooks AFB, Texas.
Stress tolerance evaluation	Reduced and revised to become provocative procedures of clinical medicine significance.
Psychiatric evaluation[c]	Integral part of medical evaluation.
* Psychometric evaluation	An integral support element of the psychiatric evaluation.

[a]Description of procedures and summary of findings.

[b]Description of procedures and summary of findings on the first 36 candidates examined at USAFSAM. Lawrence E. Lamb, M.D., former Chief, Clinical Sciences Division, USAFSAM, formulated and directed the evaluation program. The entire spectrum of USAFSAM medical departments participated on an equal basis.

[c]The psychiatric examination focused on four aspects: (a) the stress of space flight; (b) the demands of astronaut training; (c) the astronaut duties in addition to space flight, which were basically those of a project engineer for various spacecraft subsystems; and (d) the astronaut as a member/leader of an engineering/flight team.

TABLE 2. PSYCHOLOGICAL TESTS ADMINISTERED

Mercury Candidates	Gemini/Apollo Candidates
1. Wechsler Adult Intelligence Scale	1. Wechsler Adult Intelligence Scale
2. Rorschach	2. Rorschach
3. Thematic Apperception Test	3. Thematic Apperception Test
4. Edwards Personal Preference Schedule	4. Edwards Personal Preference Schedule
5. Gordon Personal Profile	5. Gordon Personal Profile
6. Spatial Orientation; Space Memory; Gottschaldt Hidden Figures	6. Bender Visual-Motor Gestalt Test
7. Draw-A-Person Test (Added by AMRL Project Officer)	7. Draw-A-Person Test (Requested by NASA)
8. Miller Analogies Test	8. Miller Analogies Test
9. Doppelt Math Reasoning Test	9. Doppelt Math Reasoning Test
10. Minnesota Engineering Analogies Test; Mechanical Comprehension	10. Minnesota Engineering Analogies Test
11. Minnesota Multiphasic Personality Inventory	11. Minnesota Multiphasic Personality Inventory
12. Raven Progressive Metrics; G-Z Spatial Visualization	(Note: Two psychomotor tests were added to the scientist-astronaut battery. One was reported in reference 7; the other was the Multidimensional Pursuit Test, which was required of the scientist candidates to predict success in pilot training.)
13. AFOQT; AQT (USN); Officer Effectiveness Inventory	
14. Sentence Completion Test; Shipley Personal Inventory; Outer-Inner Preferences; Pensacola "Z" Test; "Who Am I?" Test	
15. Extensive battery of pilot aptitude tests (WWII)	

This review will be limited to data from reference 9 (Wilson), from the first group of Gemini/Apollo candidates, and from a subset of operational pilots among 250 control subjects examined at USAFSAM to develop a baseline for astronaut data. In all, over 350 candidates were tested psychologically, but some were candidates for special USAF programs. Much of these data will not be reported anywhere. With regard to the data sets reported here, not all psychological tests were administered to all candidate/control groups, an event not uncommon when a program extends across 3+ years and is directed at different times by different psychologists. At USAFSAM, the psychology team leaders were Hagen (Powell), Hartman, and Jennings, in that order. While this will constrain the findings reported here, there are enough data sets to yield an accurate picture of astronaut candidates and to reach conclusions on the contributions of psychometric data to the medical evaluation of NASA candidates.

STATISTICAL ANALYSES

Two kinds of statistical analyses (univariate and multivariate) were performed on three sets of data (Mercury, Gemini/Apollo, control) with a variety of subset combinations.

Univariate Analyses

Five groups of subjects were compared: the 7 selected and 24 not selected Mercury astronaut candidates, the 9 selected and 23 not selected Apollo astronaut candidates, and 50 pilots considered as a control group. Thirty-six psychological measurements were considered. The Mercury candidates had data on only 16 of the measures and the controls had data on only 30 of the measures. Also, on 15 measures from the Edwards Personal Preference Schedule, data were available on only 26 of the control pilots. Percentile scores were used on the Edwards measures. The means are given in Table 3 and the standard deviations are given in Table 4 for the five groups.

Separate comparisons were made between the selected and not selected groups for the Mercury and the Apollo candidates. The only difference in means detected at the .05 level of significance was for Rating[2] for the Mercury candidates ($P < .005$). Variances differed at the .01 level for four of the measures, affecting the type of testing performed on the means. The differences in variances detected were for Rorschach F % for

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[2]Psychiatric and psychologic ratings were given at both laboratories. They could be broadly described as Outstanding, Excellent, Typical. These terms must be viewed as relative, in that all candidates came from the top of any distribution of operational pilots.

the Mercury candidates, and for Rorschach P and M and Edwards Deference for the Apollo candidates.

Separate comparisons were also made between the Mercury and Apollo candidates for the selected and not selected groups for the 16 variables with available data on both sets. The two sets differed significantly for two of the variables for both the selected and not selected groups--Rating and % Response to Chromatic Cards ($P < .001$). Also, the sets differed for Rorschach F %[3] for the selected group and for Rorschach P and W for the not selected groups ($P < .005$). None of the tests of variances were significant at the .01 level.

A closer look at the detected heterogeneities of the variances in the pairwise testing between selected and not selected groups for the two candidate sets shows an inconsistency between sets for one of the variables (Rorschach F). Another difference was on a variable not recorded on the Mercury candidates (Edwards Deference). For this variable, looking at the two variances relative to the control swt variance, it appears that the not selected group variance estimate is low. For F % and M there was some consistency between the two candidate sets. The selected group had a smaller variance for F % ($P = .011$ for the Apollo set) and a larger variance for M.

Since Rating was the only variable with a detected mean difference between selected and not selected groups (only for Mercury), and Rating was not obtained for the controls, we decided to compare the control set with each of the two candidate sets ignoring selection grouping. The means and standard deviations for these three sets of data are given in Table 5.

The controls were significantly different from the other two sets in 5 of the 14 variables with data on all three sets. The controls were lower than the other sets for all three WAIS scores and for Rorschach F + % ($P < .001$) and higher for Rorschach ΣC ($P < .025$). Heterogeneities of variances ($P < .01$) were found for controls with both sets of candidates for Rorschach R, F + %, ΣC, and Shading Response, with controls more variable in all cases. The only other heterogeneous variances detected in the comparison of the control set with the two candidate sets were for Rorschach W with the Apollo set and for Rorschach m with the Mercury set.

Of the 16 variables with data on only the Apollo and control sets, four showed significant differences. The controls were higher on the three Edwards measures: Intraception ($P < .025$), Abasement ($P < .001$), and Nurturance ($P < .05$) and lower on the Miller Analogies Test ($P < .001$). None of the variances were heterogeneous at the .01 level of significance.

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[3]Definitions of test variables will be found in Appendix A.

TABLE 3. MEANS

	Variable	Mercury Selected	Mercury Not Selected	Apollo Selected	Apollo Not Selected	Control
1.	Clin. Psych. Rating	7.6	6.5	4.3	3.8	-
2.	WAIS FSIQ	135.1	131.8	134.9	131.0	118.6
3.	WAIS VIQ	136.0	131.2	133.4	129.4	118.9
4.	WAIS PIQ	129.9	128.6	132.4	129.3	115.8
5.	Ror. # Response	32.0	31.0	37.3	26.0	35.5
6.	Ror. F + %	90.0	86.5	87.7	90.1	72.8
7.	Ror. F %	39.0	37.5	51.6	45.1	44.8
8.	Ror. A %	31.7	36.5	42.6	42.3	39.6
9.	Ror. # Popular	4.3	5.3	7.4	7.1	6.2
10.	Ror. #M	2.9	3.2	4.6	2.7	2.5
11.	Ror. #W	16.1	14.7	11.7	9.4	12.0
12.	Ror. ΣC	3.6	3.1	4.0	2.7	4.6
13.	Ror. #m	1.6	1.4	2.8	1.6	1.5
14.	Ror. #FM	4.0	4.8	5.3	4.0	3.6
15.	Ror. # Shading Response	3.9	2.5	5.4	4.0	4.3
16.	Ror. % Resp. to Chrom. Cards	36.1	35.0	58.6	54.0	-
17.	Ror. W/M	-	-	5.4	5.9	-
18.	Ror. M:FM + m	-	-	5.1	5.3	-
19.	Ror. FC:CF + C	-	-	4.7	4.4	-
20.	Ror. H + A:Hd + Ad	-	-	5.2	5.9	-
21.	Edwards Deference	-	-	49.7	50.6	49.2
22.	Edwards Order	-	-	49.3	49.2	51.0
23.	Edwards Exhibition	-	-	52.8	50.0	48.3
24.	Edwards Autonomy	-	-	51.0	52.0	49.6
25.	Edwards Affiliation	-	-	53.4	51.0	50.7
26.	Edwards Intraception	-	-	54.9	47.7	55.3
27.	Edwards Succorance	-	-	44.6	47.1	50.0
28.	Edwards Dominance	-	-	52.1	51.8	49.3
29.	Edwards Abasement	-	-	46.0	49.7	56.9
30.	Edwards Nurturance	-	-	49.4	47.1	52.7
31.	Edwards Change	-	-	51.4	50.2	49.5
32.	Edwards Endurance	-	-	53.7	50.2	52.2
33.	Edwards Heterosexuality	-	-	42.7	45.1	40.6
34.	Edwards Aggression	-	-	48.6	53.3	49.7
35.	Edwards Consistency	-	-	51.4	52.9	48.4
36.	Miller Anal Raw Score	-	-	63.2	61.1	44.0

TABLE 4. STANDARD DEVIATIONS

	Variable	Mercury		Apollo		Control
		Selected	Not Selected	Selected	Not Selected	
1.	Clin. Psych. Rating	0.60	0.88	1.52	0.79	-
2.	WAIS FSIQ	3.7	6.8	6.8	6.3	7.1
3.	WAIS VIQ	4.3	7.3	6.2	5.4	8.6
4.	WAIS PIQ	4.8	7.7	7.9	10.9	8.0
5.	Ror. # Response	15.6	18.2	15.5	13.8	27.8
6.	Ror. F + %	8.8	8.3	11.5	9.4	19.8
7.	Ror. F %	4.9	17.4	7.7	18.7	17.6
8.	Ror. A %	12.7	9.6	11.7	10.6	12.0
9.	Ror. # Popular	1.8	2.2	3.6	1.7	2.9
10.	Ror. #M	3.2	1.9	3.2	1.6	2.7
11.	Ror. #W	6.8	6.7	6.0	3.9	8.0
12.	Ror. ΣC	1.9	1.9	1.8	2.0	3.4
13.	Ror. #m	1.3	1.3	1.8	1.7	2.1
14.	Ror. #FM	2.4	3.3	2.7	2.3	2.8
15.	Ror. # Shading Response	2.9	2.5	2.8	2.8	4.5
16.	Ror. % Resp. to Chrom. Cards	8.0	7.9	7.0	7.9	-
17.	Ror. W/M	-	-	1.7	1.5	-
18.	Ror. M:FM + m	-	-	1.7	1.6	-
19.	Ror. FC:CF + C	-	-	2.1	2.5	-
20.	Ror. H + A:Hd + Ad	-	-	1.8	2.5	-
21.	Edwards Deference	-	-	11.4	5.5	8.5
22.	Edwards Order	-	-	9.7	12.2	10.4
23.	Edwards Exhibition	-	-	6.4	10.5	10.3
24.	Edwards Autonomy	-	-	9.5	10.2	8.3
25.	Edwards Affiliation	-	-	6.0	9.7	11.6
26.	Edwards Intraception	-	-	6.1	10.5	7.3
27.	Edwards Succorance	-	-	5.5	10.9	9.8
28.	Edwards Dominance	-	-	11.2	8.8	7.5
29.	Edwards Abasement	-	-	6.3	6.9	10.0
30.	Edwards Nurturance	-	-	9.3	6.7	9.9
31.	Edwards Change	-	-	7.3	8.6	8.4
32.	Edwards Endurance	-	-	10.3	10.6	11.0
33.	Edwards Heterosexuality	-	-	7.2	11.8	13.5
34.	Edwards Aggression	-	-	6.9	7.8	8.9
35.	Edwards Consistency	-	-	8.9	9.6	13.0
36.	Miller Anal Raw Score	-	-	8.1	10.5	13.4

TABLE 5. DATA COMBINED FOR SELECTED/NOT SELECTED

Variable	Means			Std. Dev.		
	Mercury	Apollo	Control	Mercury	Apollo	Control
1. Clin. Psych. Rating	6.7	3.9	-	0.94	1.05	-
2. WAIS FSIQ	132.5	132.1	118.6	6.3	6.6	7.1
3. WAIS VIQ	132.3	130.5	118.9	7.0	5.8	8.6
4. WAIS PIQ	128.9	130.2	115.8	7.1	10.1	8.0
5. Ror. # Response	31.2	29.2	35.5	17.4	15.0	27.8
6. Ror. F + %	87.3	89.4	72.8	8.4	9.9	19.8
7. Ror. F %	37.8	46.9	44.8	15.4	16.5	17.6
8. Ror. A %	35.4	42.4	39.6	10.3	10.7	12.0
9. Ror. # Popular	5.1	7.2	6.3	2.1	2.3	2.9
10. Ror. #M	3.1	3.2	2.5	2.2	2.3	2.7
11. Ror. #W	15.0	10.0	12.0	6.6	4.6	8.0
12. Ror. ΣC	3.2	3.1	4.6	1.9	2.0	3.4
13. Ror. #m	1.4	1.9	1.5	1.3	1.8	2.1
14. Ror. #FM	4.6	4.3	3.6	3.1	2.5	2.8
15. Ror. # Shading Response	2.8	4.4	4.3	2.6	2.9	4.5
16. Ror. % Resp. to Chrom. Cards	35.2	55.3	-	7.7	7.8	-
17. Ror. W/M	-	5.8	-	-	1.5	-
18. Ror. M:FM + m	-	5.2	-	-	1.6	-
19. Ror. FC:CF + C	-	4.5	-	-	2.3	-
20. Ror. H + A:Hd + Ad	-	5.7	-	-	2.3	-
21. Edwards Deference	-	50.3	49.2	-	7.5	8.5
22. Edwards Order	-	49.2	51.0	-	11.4	10.4
23. Edwards Exhibition	-	50.8	48.3	-	9.5	10.3
24. Edwards Autonomy	-	51.7	49.6	-	9.9	8.3
25. Edwards Affiliation	-	51.7	50.7	-	8.8	11.6
26. Edwards Intraception	-	49.7	55.3	-	10.0	7.3
27. Edwards Succorance	-	46.4	50.0	-	9.7	9.8
28. Edwards Dominance	-	51.9	49.3	-	9.3	7.5
29. Edwards Abasement	-	48.7	56.9	-	6.8	10.0
30. Edwards Nurturance	-	47.8	52.7	-	7.4	9.9
31. Edwards Change	-	50.6	49.5	-	8.2	8.4
32. Edwards Endurance	-	51.2	52.2	-	10.5	11.0
33. Edwards Heterosexuality	-	44.4	40.6	-	10.7	13.5
34. Edwards Aggression	-	51.9	49.7	-	7.8	8.9
35. Edwards Consistency	-	52.5	48.4	-	9.3	13.0
36. Miller Anal Raw Score	-	61.7	44.0	-	9.8	13.4

Interpretation of Univariate Analyses

On selected versus not selected, only the "rating" was significant. Selection was made by NASA, based on many more factors than psychometric data. Obviously, the psychology team leader was sensing not only test scores but also test and interview behavior in arriving at a rating. In the data, the significant difference for % Response to Chrom Cards can be considered a second-level indicator of interview/test behavior. This awareness of test behavior supplementing test performance is inherent in all good clinical practice. It can be assumed that the NASA selection board responded to some of the same behavior influencing the psychologists back in the consultation arena.

On candidates versus controls, the expected results were obtained. The controls were not as high in intellectual resources, were more dependent, and more heterogeneous in test performance (see Table 5). The senior author would add (based on personally administering around 100 of the Rorschachs out of the 350+ in the total group of special evaluations) that "special" candidates have a unique ability to deal with complex stimuli (e.g., a Rorschach card) in a simultaneously matter-of-fact and creative, emotive way--the latter without any disturbance in psychic equilibrium. This trait of astronaut candidates is distinctly different from the performance on psychological tests of the typical psychiatric patient seen on the consultation service at USAFSAM.

In general, the differences are small, scattered, and not very striking. The candidates are a brighter, better psychologically integrated, more independent, and a more homogeneous group than a randomly selected subset of USAF control group subjects. In addition, the successive groups of Gemini/Apollo candidates were highly similar, undoubtedly because each subgroup met the same initial screening standards.

Multivariate Analyses

Using a multivariate approach, comparison was made of the selected and not selected groups of the Apollo candidates. A stepwise procedure was used to obtain the subset of variables to analyze, considering only the 14 variables available on all three sets of data, so that further comparisons could be made if desired. With the stepwise procedure, each variable was in turn forced in as the first variable; the best discriminating variable in combination with the first variable was added as the second variable, providing it would improve discrimination at the .05 level of significance. Additional variables would be added in a similar manner, until no remaining variable would significantly improve discrimination.

The best set of variables found by this technique was VIQ and R. There was a significant difference between groups ($P = .026$) using these two variables. Using the best discriminating linear combination of VIQ and R resulted in misclassification of 5 of the 9 selected and 1 of the

23 not selected Apollo candidates. Therefore, about a 19% error rate in classification is in this set of data. One would expect an even higher error rate in using the criterion determined from this set to classify another set of data.

As the final step in statistical analysis, the 14 variables available on all three sets of data were factor analyzed using the Minres method which minimizes the squares of the residuals (ignoring the diagonal elements). These factors were then rotated to "simple structure" using the Quartimax method. The Minres method of factoring--when rotated to canonical form--leads to the Principal Axis factors, if the communalities obtained by the Minres method are used on the diagonal of the correlation matrix. The communality estimates are obtained as a part of the solution.

The use of all 14 variables leads to near-singularities of the correlation matrices, so we deleted FSIQ (the main cause of the near-singularities) and P from the set of variables. Using the remaining 12 variables, three factors were extracted and rotated. The three factors showed many inconsistencies between the three sets of data. Since the control subjects were deemed to be psychologically different from the more selective astronaut candidates, we looked at the factor loadings for just the two sets of astronaut candidates. Table 6 gives the factor loadings, omitting the loadings when both sets had a loading less than .3. The communality estimates are also given in Table 6.

TABLE 6. FACTOR LOADINGS AND COMMUNALITIES FOR MERCURY (M) AND APOLLO (A) DATA

Test	Factor 1		Factor 2		Factor 3		Communalities	
	M	A	M	A	M	A	M	A
VIQ	.43	-.00			-.18	.34	.23	.12
PIQ	.37	.07			-.44	.63	.40	.41
R	.93	1.00					.96	1.00
F + %			-.58	.18	.06	-.45	.34	.24
F %	.39	.12	-.29	-.58			.30	.36
A %	.37	-.07	-.05	-.49			.19	.25
M	.35	.47			.42	.47	.30	.45
W	.32	.32	.85	.41			.84	.32
ΣC	.17	.35	.77	.63			.64	.52
m	.29	.58					.12	.46
FM	.84	.66			.26	.37	.79	.58
Shading	.37	.66	.56	.37	-.32	-.23	.55	.63

To help interpret the three factors, the tests were categorized into four groupings for each factor, determined by the levels of the two loadings. These groupings are given in Table 7 for each of the three factors.

TABLE 7. GROUPING OF TESTS INTO FOUR CATEGORIES FOR EACH FACTOR

Category	Factor 1					
Major[a]	R	FM				
Moderate[b]	M	W	m	Shading		
Negligible[c]	F + %					
Inconsistent[d]	VIQ	PIQ	F %	A %	ΣC	
	Factor 2					
Major	ΣC					
Moderate	F %	Shading				
Negligible	VIQ	PIQ	R	M	m	FM
Inconsistent	F + %	A %	W			
	Factor 3					
Major						
Moderate	M	FM				
Negligible	R	F %	A %	W	ΣC	m
Inconsistent	VIQ	PIQ	F + %	Shading		

[a]Both loadings ≥ .5

[b]One loading ≥ .35 and other loading ≥ .20 with difference ≤ .40 or both loadings ≥ .30 with difference ≤ .40

[c]Both loadings < .3

[d]Not one of above

Because of the definitions of the categories, it is possible for some of the tests in the inconsistent category to have loadings that are not too different. Probably the variable "least inconsistent" is shading for factor 3 (loadings of -.32 and -.23). One of the most striking inconsistencies is PIQ for factor 3. Here, the signs are reversed and both loadings are relatively high. Changing the signs on one set of loadings would eliminate this inconsistency, but cause other tests to be inconsistent.

Interpretation of the Multivariate Analyses

In the initial multivariate analysis, the best combination of variables was Verbal IQ from the Wechsler Adult Intelligence Scale and number of responses (R) from the Rorschach. This finding is completely consistent with an early (circa 1963) unpublished factor analysis of

Mercury data, performed to provide a conceptual framework to better understand the test behavior of subsequent candidates. Our interpretation then and now is that those candidates who feel free to "produce" psychologically in response to test material make a better impression on the examiner. We should add that the "productions" must be integrated and within normal bounds to maintain the examiner's favorable impression.

In the subsequent multivariate analysis (factor analysis), we obtained findings supporting the initial analysis. Major loadings on factor 1 are R (number of responses on the Rorschach), which demonstrates willingness to "produce," and FM (movement responses on the Rorschach) which reflects ability to keep the content during high productivity within normal bounds. Moderate loadings on M (human movement responses) and W (whole inkblot responses) demonstrate the tempering of productivity by the high intellectual resources of the candidates. The major loading in factor 2 is ΣC (sum of color responses) demonstrating integrated responsiveness to one emotive aspect of Rorschach stimulation. Moderate loadings on F % (controlled conventional responses to the form of the inkblot components) coupled with shading (responses to shading variations perceived in the inkblots) which is the second emotive component of the Rorschach stimuli. Therefore, factor 2 indicates that the productivity identified in factor 1 is tempered by a combination of controlled sensitivity and responsiveness in conventional ways. Factor 3 adds nothing to this interpretation.

In summary, the multivariate analyses demonstrate the candidate's willingness to "produce" in response to test material, coupled with the added ability to respond both sensitively and creatively or in a conventional matter-of-fact manner, as appropriate to the stimulus material.

Brief note should be taken on the inconsistency of PIQ (Wechsler Adult Intelligence Scale Performance IQ) in factor 3 of the factor analysis. The senior author was struck by the occasional unexpected deviation in PIQ performance among the NASA candidates, when viewed in relation to all other test scores for those candidates. We are unable to explain this deviation; we have hypothesized that the creativity/sensitivity components of the astronaut personality structure result in unexpected "blocks" in the performance of the candidates at unpredictable points on some PIQ subtests. We are unable to defend this hypothesis with supportive data or observations beyond what we have stated here.

SUMMARY AND CONCLUSIONS

The extensive statistical analyses reported here were a necessary prerequisite to reaching the significant points of this paper. Given a certain degree of editorial leeway, our conclusions are as follows:

a. The psychometric process, embedded in a medical evaluation environment, seems to function comfortably.

b. The psychometric process yields data which, when viewed outside the context of the medical evaluation environment, are of largely unimpressive value in identifying the "best" candidates from among a superior group. In fact, psychometric data used indiscriminately outside the appropriate context would, in our opinion, be disastrous.

c. As an information base for a more inclusive psychiatric-psychologic assessment, the psychometric process is generally useful/desirable and occasionally provides critical insights.

d. The brief verbal psychometric description of an astronaut is:

1. He is brighter than most.

2. He is better integrated than most.

3. He is more independent than most.

4. He has a good balance between sensitivity/creativity and conventionality. (See references 1 and 2 for elaborations on this point.)

e. The brief data description to amplify the verbal psychometric description above can be extracted by the interested reader from Tables 3, 4, and 5.

f. None of the above will be of any particular surprise to the practicing clinical psychiatrist or psychologist.

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APPENDIX A

DEFINITIONS OF TEST VARIABLES*

1. Clin. Psych. Rating: A rating based on overall impressions and findings, on a 6-point scale.

2. WAIS FSIQ: Wechsler Adult Intelligence Scale Full Scale Intelligence Quotient, the overall intelligence score based on a combination of all sub-tests.

3. WAIS VIQ: Verbal Intelligence Quotient score based on the "verbal" sub-tests of the WAIS.

4. WAIS PIQ: Performance Intelligence Quotient score based on the "performance" sub-tests of the WAIS.

5. Ror. # Response: The total number of responses on the Rorschach Psychodiagnostic test.

6. Ror. F + %: Percentage of responses with conventional form.

7. Ror. F %: Percentage of responses determined by the blot's form.

8. Ror. A %: Percentage of animal responses.

9. Ror. # Popular (P): Number of responses which are highly conventional.

10. Ror. #M: Number of human movement responses.

11. Ror. #W: Number of responses using the whole blot.

12. Ror. ΣC: A weighted sum of color responses.

13. Ror. #m: Number of inanimate "movement" responses.

14. Ror. #FM: Number of animal movement responses.

15. Ror. # Shading Response: Number of shading (texture) responses with form predominant.

16. Ror. % Response to Chrom. Cards: Percentage of responses to the chromatic ("colored") blots.

17. Ror. W/M: Ratio of whole blot responses to human movement responses.

18. Ror. M:FM + m: Ratio of human movement responses to animal and inanimate movement responses.

19. Ror. FC:CF + C: Ratio of form-predominant color responses to the remaining color responses.

20. Ror. H + A:Hd + Ad: Ratio of whole human/animal responses to parts of humans/animals, e.g., "a bat" vs. "the head of a bat."

*The interpretations of Rorschach scores are more fully explained in reference 2 (Fine and Hartman) which is specific to military pilots, and in numerous textbooks, which deal with the general adult population.